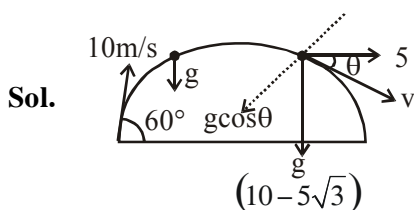


**TEST PAPER OF JEE(MAIN) EXAMINATION – 2019**  
**(Held On Friday 11<sup>th</sup> JANUARY, 2019) TIME : 9 : 30 AM To 12 : 30 PM**  
**PHYSICS**

1. A body is projected at  $t = 0$  with a velocity  $10 \text{ ms}^{-1}$  at an angle of  $60^\circ$  with the horizontal. The radius of curvature of its trajectory at  $t = 1 \text{ s}$  is  $R$ . Neglecting air resistance and taking acceleration due to gravity  $g = 10 \text{ ms}^{-2}$ , the value of  $R$  is :

- (1) 2.5 m                      (2) 10.3 m  
 (3) 2.8 m                      (4) 5.1 m

Ans. (3)



$$v_x = 10 \cos 60^\circ = 5 \text{ m/s}$$

$$v_y = 10 \cos 30^\circ = 5\sqrt{3} \text{ m/s}$$

velocity after  $t = 1 \text{ sec}$ .

$$v_x = 5 \text{ m/s}$$

$$v_y = \left| (5\sqrt{3} - 10) \right| \text{ m/s} = 10 - 5\sqrt{3}$$

$$a_n = \frac{v^2}{R} \Rightarrow R = \frac{v_x^2 + v_y^2}{a_n} = \frac{25 + 100 + 75 - 100\sqrt{3}}{10 \cos \theta}$$

$$\tan \theta = \frac{10 - 5\sqrt{3}}{5} = 2 - \sqrt{3} \Rightarrow \theta = 15^\circ$$

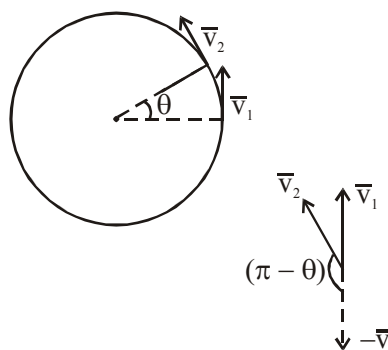
$$R = \frac{100(2 - \sqrt{3})}{10 \cos 15^\circ} = 2.8 \text{ m}$$

2. A particle is moving along a circular path with a constant speed of  $10 \text{ ms}^{-1}$ . What is the magnitude of the change in velocity of the particle, when it moves through an angle of  $60^\circ$  around the centre of the circle?

- (1) zero                      (2)  $10 \text{ m/s}$   
 (3)  $10\sqrt{3} \text{ m/s}$                       (4)  $10\sqrt{2} \text{ m/s}$

Ans. (2)

Sol.



$$|\Delta \vec{v}| = \sqrt{v_1^2 + v_2^2 + 2v_1v_2 \cos(\pi - \theta)}$$

$$= 2v \sin \frac{\theta}{2} \quad \text{since } [|\vec{v}_1| = |\vec{v}_2|]$$

$$= (2 \times 10) \times \sin(30^\circ) \\ = 10 \text{ m/s}$$

3. A hydrogen atom, initially in the ground state is excited by absorbing a photon of wavelength  $980 \text{ \AA}$ . The radius of the atom in the excited state, in terms of Bohr radius  $a_0$ , will be :

$$(h_c = 12500 \text{ eV} - \text{\AA})$$

- (1)  $9a_0$                       (2)  $25a_0$                       (3)  $4a_0$                       (4)  $16a_0$

Ans. (4)

Sol. Energy of photon =  $\frac{12500}{980} = 12.75 \text{ eV}$

$\therefore$  Electron will excite to  $n = 4$

Since ' $R$ '  $\propto n^2$

$\therefore$  Radius of atom will be  $16a_0$

4. A liquid of density  $\rho$  is coming out of a hose pipe of radius  $a$  with horizontal speed  $v$  and hits a mesh. 50% of the liquid passes through the mesh unaffected. 25% loses all of its momentum and 25% comes back with the same speed. The resultant pressure on the mesh will be :

- (1)  $pv^2$                       (2)  $\frac{3}{4}pv^2$   
 (3)  $\frac{1}{2}pv^2$                       (4)  $\frac{1}{4}pv^2$

Ans. (2)

**Sol.** Momentum per second carried by liquid per second is  $\rho av^2$

$$\text{net force due to reflected liquid} = 2 \times \left[ \frac{1}{4} \rho av^2 \right]$$

$$\text{net force due to stopped liquid} = \frac{1}{4} \rho av^2$$

$$\text{Total force} = \frac{3}{4} \rho av^2$$

$$\text{net pressure} = \frac{3}{4} \rho v^2$$

- 5.** An electromagnetic wave of intensity  $50 \text{ Wm}^{-2}$  enters in a medium of refractive index 'n' without any loss. The ratio of the magnitudes of electric fields, and the ratio of the magnitudes of magnetic fields of the wave before and after entering into the medium are respectively, given by :

$$(1) \left( \frac{1}{\sqrt{n}}, \frac{1}{\sqrt{n}} \right)$$

$$(2) \left( \sqrt{n}, \frac{1}{\sqrt{n}} \right)$$

$$(3) \left( \sqrt{n}, \sqrt{n} \right)$$

$$(4) \left( \frac{1}{\sqrt{n}}, \sqrt{n} \right)$$

**Ans. (2)**

**Sol.**  $C = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$

$$V = \frac{1}{\sqrt{k \epsilon_0 \mu_0}} \text{ [For transparent medium } \mu_r \approx \mu_0]$$

$$\therefore \frac{C}{V} = \sqrt{k} = n$$

$$\frac{1}{2} \epsilon_0 E_0^2 C = \text{intensity} = \frac{1}{2} \epsilon_0 k E^2 v$$

$$\therefore E_0^2 C = k E^2 v$$

$$\Rightarrow \frac{E_0^2}{E^2} = \frac{kV}{C} = \frac{n^2}{n} \Rightarrow \frac{E_0}{E} = \sqrt{n}$$

similarly

$$\frac{B_0^2 C}{2\mu_0} = \frac{B^2 v}{2\mu_0} \Rightarrow \frac{B_0}{B} = \frac{1}{\sqrt{n}}$$

- 6.** An amplitude modulated signal is given by  $V(t) = 10[1 + 0.3\cos(2.2 \times 10^4)]\sin(5.5 \times 10^5 t)$ . Here t is in seconds. The sideband frequencies (in kHz) are, [Given  $\pi = 22/7$ ]
- (1) 1785 and 1715
  - (2) 892.5 and 857.5
  - (3) 89.25 and 85.75
  - (4) 178.5 and 171.5

**Ans. (3)**

**Sol.**  $V(t) = 10 + \frac{3}{2} [2\cos A \sin B]$

$$= 10 + \frac{3}{2} [\sin(A+B) - \sin(A-B)]$$

$$= 10 + \frac{3}{2} [\sin(57.2 \times 10^4 t) - \sin(52.8 \times 10^4 t)]$$

$$\omega_1 = 57.2 \times 10^4 = 2\pi f_1$$

$$f_1 = \frac{57.2 \times 10^4}{2 \times \left( \frac{22}{7} \right)} = 9.1 \times 10^4$$

$$\approx 91 \text{ KHz}$$

$$f_2 = \frac{52.8 \times 10^4}{2 \times \left( \frac{22}{7} \right)}$$

$$\approx 84 \text{ KHz}$$



Side band frequency are

$$f_1 = f_c - f_w = \frac{52.8 \times 10^4}{2\pi} \approx 85.00 \text{ kHz}$$

$$f_2 = f_c + f_w = \frac{57.2 \times 10^4}{2\pi} \approx 90.00 \text{ kHz}$$

7. The force of interaction between two atoms is given by  $F = \alpha\beta \exp\left(-\frac{x^2}{\alpha kt}\right)$ ; where  $x$  is the distance,  $k$  is the Boltzmann constant and  $T$  is temperature and  $\alpha$  and  $\beta$  are two constants. The dimension of  $\beta$  is :

- (1)  $M^2L^2T^{-2}$   
 (2)  $M^2LT^{-4}$   
 (3)  $M^0L^2T^{-4}$   
 (4)  $MLT^{-2}$

**Ans. (2)**

**Sol.**  $F = \alpha\beta e^{\left(\frac{-x^2}{\alpha KT}\right)}$

$$\left[\frac{x^2}{\alpha KT}\right] = M^0L^0T^0$$

$$\frac{L^2}{[\alpha]ML^2T^{-2}} = M^0L^0T^0$$

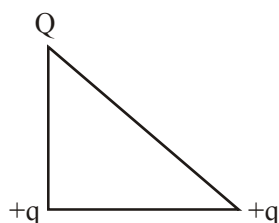
$$\Rightarrow [\alpha] = M^{-1}T^2$$

$$[F] = [\alpha][\beta]$$

$$MLT^{-2} = M^{-1}T^2[\beta]$$

$$\Rightarrow [\beta] = M^2LT^{-4}$$

8. The charges  $Q + q$  and  $+q$  are placed at the vertices of a right-angle isosceles triangle as shown below. The net electrostatic energy of the configuration is zero, the value of  $Q$  is:



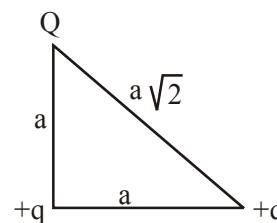
- (1)  $\frac{-\sqrt{2}q}{\sqrt{2}+1}$                       (2)  $-2q$   
 (3)  $\frac{-q}{1+\sqrt{2}}$                       (4)  $+q$

**Ans. (1)**

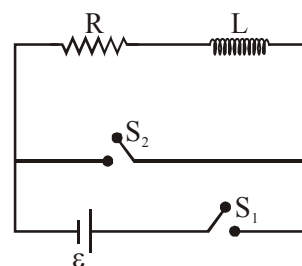
**Sol.**  $U = K\left[\frac{q^2}{a} + \frac{Qq}{a} + \frac{Qq}{a\sqrt{2}}\right] = 0$

$$\Rightarrow q = -Q\left[1 + \frac{1}{\sqrt{2}}\right]$$

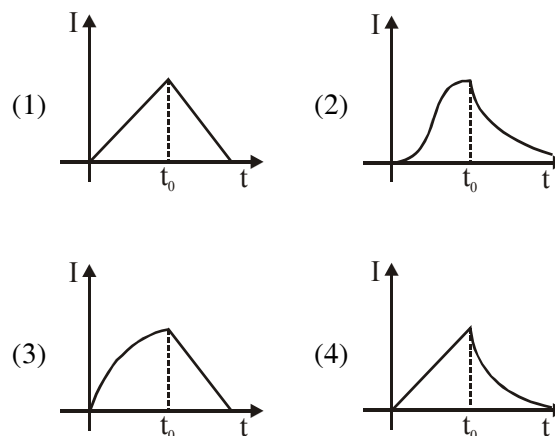
$$\Rightarrow Q = \frac{-q\sqrt{2}}{\sqrt{2}+1}$$



9. In the circuit shown,

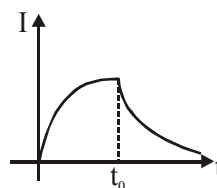


the switch  $S_1$  is closed at time  $t = 0$  and the switch  $S_2$  is kept open. At some later time ( $t_0$ ), the switch  $S_1$  is opened and  $S_2$  is closed. The behaviour of the current  $I$  as a function of time ' $t$ ' is given by :



**Ans. (2)**

**Sol.** From time  $t = 0$  to  $t = t_0$ , growth of current takes place and after that decay of current takes place.



most appropriate is (2)

- 10.** Equation of travelling wave on a stretched string of linear density 5 g/m is  $y = 0.03 \sin(450t - 9x)$  where distance and time are measured in SI units. The tension in the string is :  
 (1) 10 N (2) 12.5 N (3) 7.5 N (4) 5 N

**Ans. (2)**

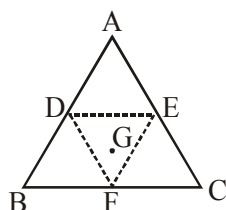
**Sol.**  $y = 0.03 \sin(450t - 9x)$

$$v = \frac{\omega}{k} = \frac{450}{9} = 50 \text{ m/s}$$

$$v = \sqrt{\frac{T}{\mu}} \Rightarrow \frac{T}{\mu} = 2500$$

$$\Rightarrow T = 2500 \times 5 \times 10^{-3} = 12.5 \text{ N}$$

- 11.** An equilateral triangle ABC is cut from a thin solid sheet of wood. (see figure) D, E and F are the mid-points of its sides as shown and G is the centre of the triangle. The moment of inertia of the triangle about an axis passing through G and perpendicular to the plane of the triangle is  $I_0$ . If the smaller triangle DEF is removed from ABC, the moment of inertia of the remaining figure about the same axis is I. Then:



- (1)  $I = \frac{9}{16} I_0$  (2)  $I = \frac{3}{4} I_0$   
 (3)  $I = \frac{I_0}{4}$  (4)  $I = \frac{15}{16} I_0$

**Ans. (4)**

**Sol.** Suppose M is mass and a is side of larger triangle, then  $\frac{M}{4}$  and  $\frac{a}{2}$  will be mass and side length of smaller triangle.

$$\frac{I_{\text{removed}}}{I_{\text{original}}} = \frac{\frac{M}{4} \left(\frac{a}{2}\right)^2}{M (a)^2}$$

$$I_{\text{removed}} = \frac{I_0}{16}$$

$$\text{So, } I = I_0 - \frac{I_0}{16} = \frac{15I_0}{16}$$

- 12.** There are two long co-axial solenoids of same length  $l$ . the inner and outer coils have radii  $r_1$  and  $r_2$  and number of turns per unit length  $n_1$  and  $n_2$  respectively. The ratio of mutual inductance to the self-inductance of the inner-coil is :

- (1)  $\frac{n_2}{n_1} \cdot \frac{r_2^2}{r_1^2}$  (2)  $\frac{n_2}{n_1} \cdot \frac{r_1}{r_2}$  (3)  $\frac{n_1}{n_2}$  (4)  $\frac{n_2}{n_1}$

**Ans. (4)**

**Sol.**  $M = \mu_0 n_1 n_2 \pi r_1^2$

$$L = \mu_0 n_1^2 \pi r_1^2$$

$$\Rightarrow \frac{M}{L} = \frac{n_2}{n_1}$$

- 13.** A rigid diatomic ideal gas undergoes an adiabatic process at room temperature. The relation between temperature and volume of this process is  $TV^x = \text{constant}$ , then x is :

- (1)  $\frac{5}{3}$  (2)  $\frac{2}{5}$  (3)  $\frac{2}{3}$  (4)  $\frac{3}{5}$

**Ans. (2)**

**Sol.** For adiabatic process :  $TV^{\gamma-1} = \text{constant}$

$$\text{For diatomic process : } \gamma - 1 = \frac{7}{5} - 1$$

$$\therefore x = \frac{2}{5}$$

- 14.** The gas mixture consists of 3 moles of oxygen and 5 moles of argon at temperature T. Considering only translational and rotational modes, the total internal energy of the system is:  
 (1) 12 RT (2) 20 RT (3) 15 RT (4) 4 RT

**Ans. (3)**

**Sol.**  $U = \frac{f_1}{2} n_1 RT + \frac{f_2}{2} n_2 RT$

$$= \frac{5}{2} (3RT) + \frac{3}{2} \times 5RT$$

$$U = 15RT$$

- 15.** In a Young's double slit experiment, the path different, at a certain point on the screen, between two interfering waves is  $\frac{1}{8}$ th of wavelength. The ratio of the intensity at this point to that at the centre of a bright fringe is close to :
- (1) 0.94      (2) 0.74      (3) 0.85      (4) 0.80

**Ans. (3)**

**Sol.**  $\Delta x = \frac{\lambda}{8}$

$$\Delta\phi = \frac{(2\pi)\lambda}{\lambda} \frac{1}{8} = \frac{\pi}{4}$$

$$I = I_0 \cos^2\left(\frac{\pi}{8}\right)$$

$$\frac{I}{I_0} = \cos^2\left(\frac{\pi}{8}\right)$$

- 16.** If the deBroglie wavelength of an electron is equal to  $10^{-3}$  times the wavelength of a photon of frequency  $6 \times 10^{14}$  Hz, then the speed of electron is equal to :
- (Speed of light =  $3 \times 10^8$  m/s  
Planck's constant =  $6.63 \times 10^{-34}$  J.s  
Mass of electron =  $9.1 \times 10^{-31}$  kg)
- (1)  $1.45 \times 10^6$  m/s      (2)  $1.7 \times 10^6$  m/s  
(3)  $1.8 \times 10^6$  m/s      (4)  $1.1 \times 10^6$  m/s

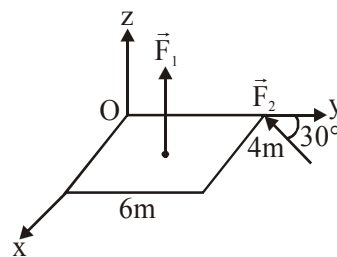
**Ans. (1)**

**Sol.**  $\frac{h}{mv} = 10^{-3} \left( \frac{3 \times 10^8}{6 \times 10^{14}} \right)$

$$v = \frac{6.63 \times 10^{-34} \times 6 \times 10^{14}}{9.1 \times 10^{-31} \times 3 \times 10^5}$$

$$v = 1.45 \times 10^6 \text{ m/s}$$

- 17.** A slob is subjected to two forces  $\vec{F}_1$  and  $\vec{F}_2$  of same magnitude  $F$  as shown in the figure. Force  $\vec{F}_2$  is in XY-plane while force  $F_1$  acts along z-axis at the point  $(2\vec{i} + 3\vec{j})$ . The moment of these forces about point O will be :



(1)  $(3\hat{i} - 2\hat{j} - 3\hat{k})F$       (2)  $(3\hat{i} + 2\hat{j} + 3\hat{k})F$

(3)  $(3\hat{i} + 2\hat{j} - 3\hat{k})F$       (4)  $(3\hat{i} - 2\hat{j} + 3\hat{k})F$

**Ans. (4)**

**Sol.** Torque for  $F_1$  force

$$\vec{F}_1 = \frac{F}{2}(-\hat{i}) + \frac{F\sqrt{3}}{2}(-\hat{j})$$

$$\vec{r}_1 = 0\hat{i} + 6\hat{j}$$

$$\vec{\tau}_{F_1} = \vec{r}_1 \times \vec{F}_1 = 3F\hat{k}$$

Torque for  $F_2$  force

$$\vec{F}_2 = F\hat{k}$$

$$\vec{r}_2 = 2\hat{i} + 3\hat{j}$$

$$\vec{\tau}_{F_2} = \vec{r}_2 \times \vec{F}_2 = 3F\hat{i} + 2F(-\hat{j})$$

$$\vec{\tau}_{\text{net}} = \vec{\tau}_{F_1} + \vec{\tau}_{F_2}$$

$$= 3F\hat{i} + 2F(-\hat{j}) + 3F(\hat{k})$$

- 18.** A satellite is revolving in a circular orbit at a height  $h$  from the earth surface, such that  $h \ll R$  where  $R$  is the radius of the earth. Assuming that the effect of earth's atmosphere can be neglected the minimum increase in the speed required so that the satellite could escape from the gravitational field of earth is :

(1)  $\sqrt{gR}(\sqrt{2} - 1)$

(2)  $\sqrt{2gR}$

(3)  $\sqrt{gR}$

(4)  $\sqrt{\frac{gR}{2}}$

**Ans. (1)**

**Sol.**  $v_0 = \sqrt{g(R+h)} \approx \sqrt{gR}$

$$v_e = \sqrt{2g(R+h)} \approx \sqrt{2gR}$$

$$\Delta v = v_e - v_0 = (\sqrt{2} - 1)\sqrt{gR}$$

- 19.** In an experiment electrons are accelerated, from rest, by applying a voltage of 500 V. Calculate the radius of the path if a magnetic field 100 mT is then applied.

[Charge of the electron =  $1.6 \times 10^{-19}$  C

Mass of the electron =  $9.1 \times 10^{-31}$  kg]

(1)  $7.5 \times 10^{-4}$  m                      (2)  $7.5 \times 10^{-3}$  m

(3) 7.5 m                                      (4)  $7.5 \times 10^{-2}$  m

**Ans. (1)**

**Sol.**  $r = \frac{\sqrt{2mk}}{eB} = \frac{\sqrt{2me\Delta v}}{eB}$

$$r = \frac{\sqrt{\frac{2m}{e} \cdot \Delta v}}{B} = \frac{\sqrt{\frac{2 \times 9.1 \times 10^{-31}}{1.6 \times 10^{-19}} (500)}}{100 \times 10^{-3}}$$

$$r = \frac{\sqrt{\frac{9.1}{0.16} \times 10^{-10}}}{10^{-1}} = \frac{3}{4} \times 10^{-4} = 7.5 \times 10^{-4}$$

- 20.** A particle undergoing simple harmonic motion has time dependent displacement given by  $x(t) = A \sin \frac{\pi t}{90}$ . The ratio of kinetic to potential energy of this particle at  $t = 210$  s will be :

(1) 2                      (2)  $\frac{1}{9}$                       (3) 3                      (4) 1

**Ans. (3)**

**Sol.**  $k = \frac{1}{2} m \omega^2 A^2 \cos^2 \omega t$

$$U = \frac{1}{2} m \omega^2 A^2 \sin^2 \omega t$$

$$\frac{k}{U} = \cot^2 \omega t = \cot^2 \frac{\pi}{90} (210) = \frac{1}{3}$$

Hence ratio is 3 (most appropriate)

- 21.** Ice at  $-20^\circ$  C is added to 50 g of water at  $40^\circ$  C. When the temperature of the mixture reaches  $0^\circ$  C, it is found that 20 g of ice is still unmelted. The amount of ice added to the water was close to (Specific heat of water =  $4.2$  J/g/ $^\circ$ C)

Specific heat of Ice =  $2.1$  J/g/ $^\circ$ C

Heat of fusion of water at  $0^\circ$  C =  $334$  J/g

(1) 50 g                                      (2) 40 g

(3) 60 g                                      (4) 100 g

**Ans. (2)**

**Sol.** Let amount of ice is  $m$  gm.

According to principle of calorimeter

heat taken by ice = heat given by water

$$\therefore 20 \times 2.1 \times m + (m - 20) \times 334$$

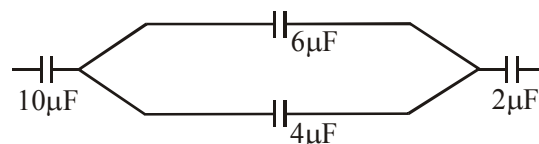
$$= 50 \times 4.2 \times 40$$

$$376 m = 8400 + 6680$$

$$m = 40.1$$

$\therefore$  correct answer is (2)

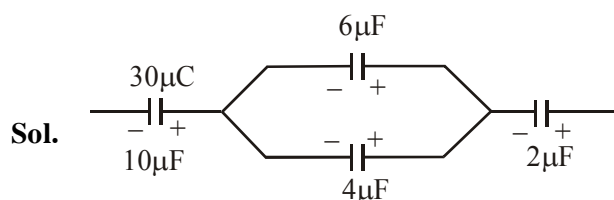
- 22.** In the figure shown below, the charge on the left plate of the  $10 \mu\text{F}$  capacitor is  $-30 \mu\text{C}$ . The charge on the right plate of the  $6 \mu\text{F}$  capacitor is :



(1)  $-18 \mu\text{C}$                                       (2)  $-12 \mu\text{C}$

(3)  $+12 \mu\text{C}$                                       (4)  $+18 \mu\text{C}$

**Ans. (4)**



**Sol.**

$6 \mu\text{F}$  &  $4 \mu\text{F}$  are in parallel & total charge on this combination is  $30 \mu\text{C}$

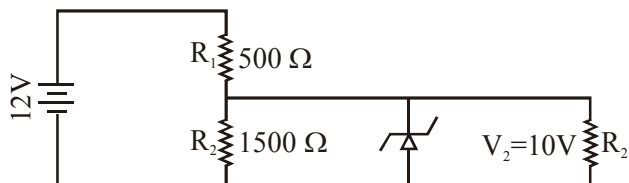
$$\therefore \text{Charge on } 6 \mu\text{F capacitor} = \frac{6}{6+4} \times 30$$

$$= 18 \mu\text{C}$$

Since charge is asked on right plate therefore is  $+18 \mu\text{C}$

Correct answer is (4)

- 23.** In the given circuit the current through Zener Diode is close to :

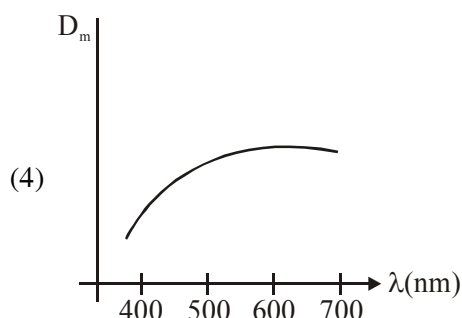
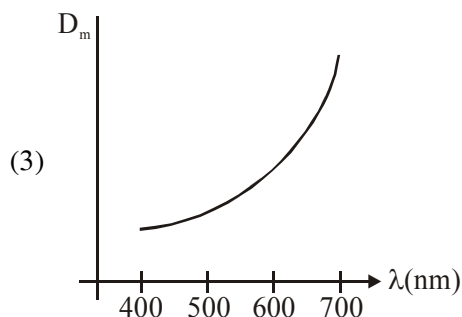
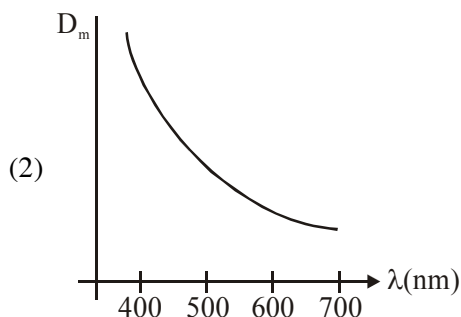
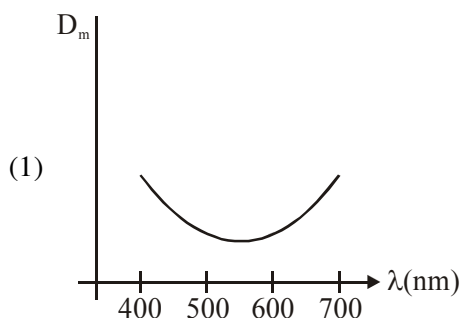
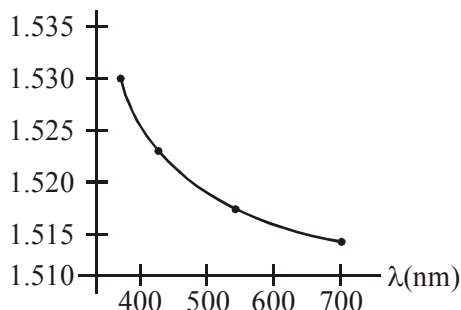


- (1) 6.0 mA                      (2) 4.0 mA  
(3) 6.7 mA                      (4) 0.0 mA

**Ans. (4)**

**Sol.** Since voltage across zener diode must be less than 10V therefore it will not work in breakdown region, & its resistance will be infinite & current through it = 0  
∴ correct answer is (4)

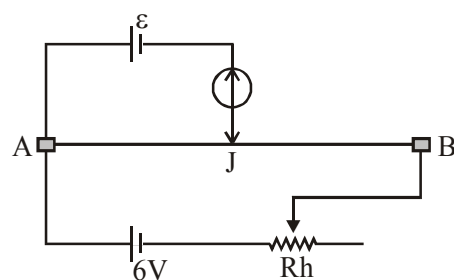
- 24.** The variation of refractive index of a crown glass thin prism with wavelength of the incident light is shown. Which of the following graphs is the correct one, if  $D_m$  is the angle of minimum deviation?



**Ans. (2)**

**Sol.** Since  $D_m = (\mu - 1)A$   
& on increasing the wavelength,  $\mu$  decreases  
& hence  $D_m$  decreases. Therefore correct answer is (2)

- 25.** The resistance of the meter bridge AB is given figure is  $4\Omega$ . With a cell of emf  $\varepsilon = 0.5$  V and rheostat resistance  $R_h = 2\Omega$  the null point is obtained at some point J. When the cell is replaced by another one of emf  $\varepsilon = \varepsilon_2$  the same null point J is found for  $R_h = 6\Omega$ . The emf  $\varepsilon_2$  is;



- (1) 0.6 V                      (2) 0.5 V  
(3) 0.3 V                      (4) 0.4 V

**Ans. (3)**

**Sol.** Potential gradient with  $R_h = 2\Omega$

is  $\left(\frac{6}{2+4}\right) \times \frac{4}{L} = \frac{dV}{dL}$ ;  $L = 100 \text{ cm}$

Let null point be at  $\ell$  cm

thus  $\varepsilon_1 = 0.5 \text{ V} = \left(\frac{6}{2+4}\right) \times \frac{4}{L} \times \ell \quad \dots(1)$

Now with  $R_h = 6\Omega$  new potential gradient is

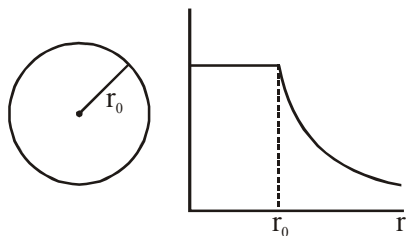
$\left(\frac{6}{4+6}\right) \times \frac{4}{L}$  and at null point

$\left(\frac{6}{4+6}\right) \left(\frac{4}{L}\right) \times \ell = \varepsilon_2 \quad \dots(2)$

dividing equation (1) by (2) we get

$\frac{0.5}{\varepsilon_2} = \frac{10}{6}$  thus  $\varepsilon_2 = 0.3$

- 26.** The given graph shows variation (with distance  $r$  from centre) of :



- (1) Potential of a uniformly charged sphere
- (2) Potential of a uniformly charged spherical shell
- (3) Electric field of uniformly charged spherical shell
- (4) Electric field of uniformly charged sphere

**Ans. (2)**

- 27.** Two equal resistance when connected in series to a battery, consume electric power of 60 W. If these resistances are now connected in parallel combination to the same battery, the electric power consumed will be :

- (1) 60 W
- (2) 240 W
- (3) 30 W
- (4) 120 W

**Ans. (2)**

**Sol.** In series condition, equivalent resistance is  $2R$

thus power consumed is  $60 \text{ W} = \frac{\varepsilon^2}{2R}$

In parallel condition, equivalent resistance is  $R/2$  thus new power is

$P' = \frac{\varepsilon^2}{(R/2)}$

or  $P' = 4P = 240 \text{ W}$

- 28.** An object is at a distacen of 20 m from a convex lens of focal length 0.3 m. The lens forms an image of the object. If the object moves away from the lens at a speed of 5 m/s, the speed and direction of the image will be :
- (1)  $0.92 \times 10^{-3} \text{ m/s}$  away from the lens
  - (2)  $2.26 \times 10^{-3} \text{ m/s}$  away from the lens
  - (3)  $1.16 \times 10^{-3} \text{ m/s}$  towards the lens
  - (4)  $3.22 \times 10^{-3} \text{ m/s}$  towards the lens

**Ans. (3)**

**Sol.** From lens equation

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{(-20)} = \frac{1}{(0.3)} = \frac{10}{3}$

$\frac{1}{v} = \frac{10}{3} - \frac{1}{20}$

$\frac{1}{v} = \frac{197}{60}$ ;  $v = \frac{60}{197}$

$m = \left(\frac{v}{u}\right) = \left(\frac{60}{197}\right)$

velocity of image wrt. to lens is given by

$v_{IL} = m^2 v_{OL}$

direction of velocity of image is same as that of object

$v_{OL} = 5 \text{ m/s}$



$$v_{IL} = \left( \frac{60 \times 1}{197 \times 20} \right)^2 (5)$$

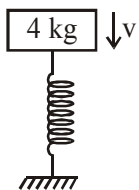
$$= 1.16 \times 10^{-3} \text{ m/s towards the lens}$$

- 29.** A body of mass 1 kg falls freely from a height of 100 m on a platform of mass 3 kg which is mounted on a spring having spring constant  $k = 1.25 \times 10^6 \text{ N/m}$ . The body sticks to the platform and the spring's maximum compression is found to be  $x$ . Given that  $g = 10 \text{ ms}^{-2}$ , the value of  $x$  will be close to :
- (1) 4 cm  
(2) 8 cm  
(3) 80 cm  
(4) 40 cm

**Ans. (1)**

**Sol.** Velocity of 1 kg block just before it collides with 3kg block  $= \sqrt{2gh} = \sqrt{2000} \text{ m/s}$   
Applying momentum conservation just before and just after collision.

$$1 \times \sqrt{2000} = 4v \Rightarrow v = \frac{\sqrt{2000}}{4} \text{ m/s}$$



initial compression of spring

$$1.25 \times 10^6 x_0 = 30 \Rightarrow x_0 \approx 0$$

applying work energy theorem,

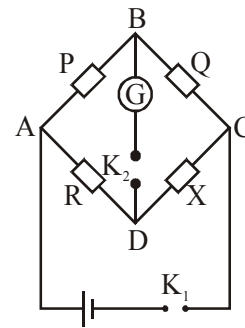
$$W_g + W_{sp} = \Delta KE$$

$$\Rightarrow 40 \times x + \frac{1}{2} \times 1.25 \times 10^6 (0^2 - x^2)$$

$$= 0 - \frac{1}{2} \times 4 \times v^2$$

solving  $x \approx 4 \text{ cm}$

- 30.** In a Wheatstone bridge (see fig.), Resistances P and Q are approximately equal. When  $R = 400 \Omega$ , the bridge is equal. When  $R = 400 \Omega$ , the bridge is balanced. On inter-changing P and Q, the value of R, for balance, is 405  $\Omega$ . The value of X is close to :



- (1) 403.5 ohm                      (2) 404.5 ohm  
(3) 401.5 ohm                      (4) 402.5 ohm

**Ans. (4)**